

STANDARDS FOR PROJECT AND LARGER GROUP JOBS

Standard staking and note keeping procedures are shown for representative type structures and portions of structures. They do not cover every situation. The illustrations show format and procedure in sufficient detail for the field engineer or survey party chief to apply them to the particular job. Construction staking must be consistent with contract provisions, and some of the illustrations may represent portions that are the responsibility of the contractor.

Unless otherwise specified basic staking for embankments and excavations includes centerline, slope (toe of slope or edge of cut) and offset reference stakes with hubs at each station and more frequently on curves along the axis of the embankment or excavation. It also includes stakes at significant breaks in topography or changes in section of the planned work. Basic staking for structures includes alignment and grade along the principal axis and may include offset stakes for long structures such as a principal spillway through a dam.

Computations are closely related to notekeeping. These samples can be used to compute quantities directly from the field notes. Placing the cut or fill above the distance from centerline or reference point facilitates direct computations. A sample plotted dam cross section and computation are shown.

Figures 3-1 through 3-4 show components of a typical floodwater retarding structure. These exhibits are referred to in the presentation of the sample field notes for layout and also for calculations. Although these figures and the field notes presented are for an earth dam, the content, procedures and completeness of note keeping are directly applicable to other major construction work.

Engineering Notes - Bench Mark Surveys

The engineering notes shown in Figure 3-5 illustrate the format for setting and checking bench marks (vertical control) for construction layout.

Note that B.M. No 81-1 and B.M. 81-6 are permanent monuments, and are so recorded on the drawings. Temporary benches should be run from the datum described in the contract drawings. All bench mark elevations should be thoroughly checked before other level work is started.

Engineering Notes - Construction Grades

Figures 3-6 through 3-8 show the planned grades for the embankment, cut-off trench, principal spillway, and emergency spillway.

Elevations and stationing or dimensions for all the major structure elements should be entered in the field notebook prior to layout. Spacing between entries should be sufficient for the field notes. Crowded notes are difficult to read and can cause errors. The inspector may find a condensed version of the same information helpful for a quick reference.

Elevations for earthwork are usually computed to the nearest one-tenth (0.1) foot. Where grades or control elevations are not shown on the drawings, sufficient information for rough grading may be established by scaled measurements taken from the drawings.

It is standard practice to set grades for the various elements of structures to the nearest one-hundredth (0.01) of a foot.

All construction stakes should be set and marked to show finish elevation. Additional information may be added to stakes and notes for subgrades or other specific construction datums as needed.

Engineering Notes -- Construction Stakeout

Figure 3-9 illustrates a format for stakeout notes for dams or other embankments. The elevations and structure dimensions illustrated are from plan data in Figures 3-1 through 3-4 and field notebook Figure 3-6.

The example shows the original cross section and embankment staking. The foundation was stripped and a second cross section was taken concurrently with setting the cutoff trench cut stakes. This is an optional procedure and in some cases one cross section will be sufficient. The (T) denotes the edge (toe) of fill or cut.

The computer program, STAKE, may be used to develop tables of horizontal distances from the toe of dam to the centerline for all expected fills. This can improve efficiency and accuracy of survey crews.

Figure 3-10 illustrates a format that may be used for recording the layout notes for the construction of principal spillways for flood control dams, and can also be readily adapted for use in laying out other types of closed conduits or culverts.

Figure 3-11 illustrates format that may be used for recording notes for the cross sections and the layout of the emergency spillway or other earth work. The work may consist of excavation, or sections which combine excavation and embankment.

The layout (including curve data) and the elevations for this example were taken from Figure 3-8. Simple curves are frequently required in the layout of embankments, excavations or elements of structures.

Stationing for the project should be continued along the centerline of the curve at the time of stakeout, and these stations should be used as control points for cross sections and the staking of the structure limits. Transverse measurements are made normal to the tangent to the curve at the point under consideration. This measurement line parallels an imaginary line that passes through the centerline station and the reference or radius point for the curve.

Plotting and Computations

Figure 3-12 shows the plotted cross section of dam centerline station 15 + 10. Fill height and distance from the centerline are the parameters used for plotting. Calculations should normally be made directly from field notes. It may be necessary in cases of complex geometry to plot cross sections to visualize the element. However, copying numbers and plotting cross sections should be kept to the minimum. There are computer programs available for computing quantities, some directly from rod readings. They may be used where appropriate. Figure 3-13 shows a convenient way of tabulating field notes for calculations where it is not convenient to compute directly from the fieldbook.

Setting and Marking Stakes

Figure 3-14 shows an example for staking embankments. This is the same cross section as recorded on Figure 3-9. Figure 3-15 shows an example for staking an open channel spillway. This is the same cross section as recorded for emergency spillway station 9 + 12 on Figure 3-11. The berm was added to the sketch to show the procedure (not in notes.) Stake location and markings must convey the necessary information. The examples show proven methods but may be varied to accomplish this objective.

Figure 3-16 shows stake marking for various purposes applicable to construction.

Figures 3-17, 3-18 and 3-19 show methods of staking various other structures.

Engineering Notes - Checking Completed Work

Figure 3-20 shows an example of recording a check of completed construction and although an embankment is shown, the principles are applicable for all construction work.

Some technicians develop a checkout schedule similar to the stakeout schedule based on constructed fill height to the dam centerline. Use of such schedules may be appropriate for large complex dams. The notes shown, along with good visual judgement should be sufficient for the ordinary dam. A plot of the planned embankment section overlain with the constructed cross section can also be made to visually compare the two.

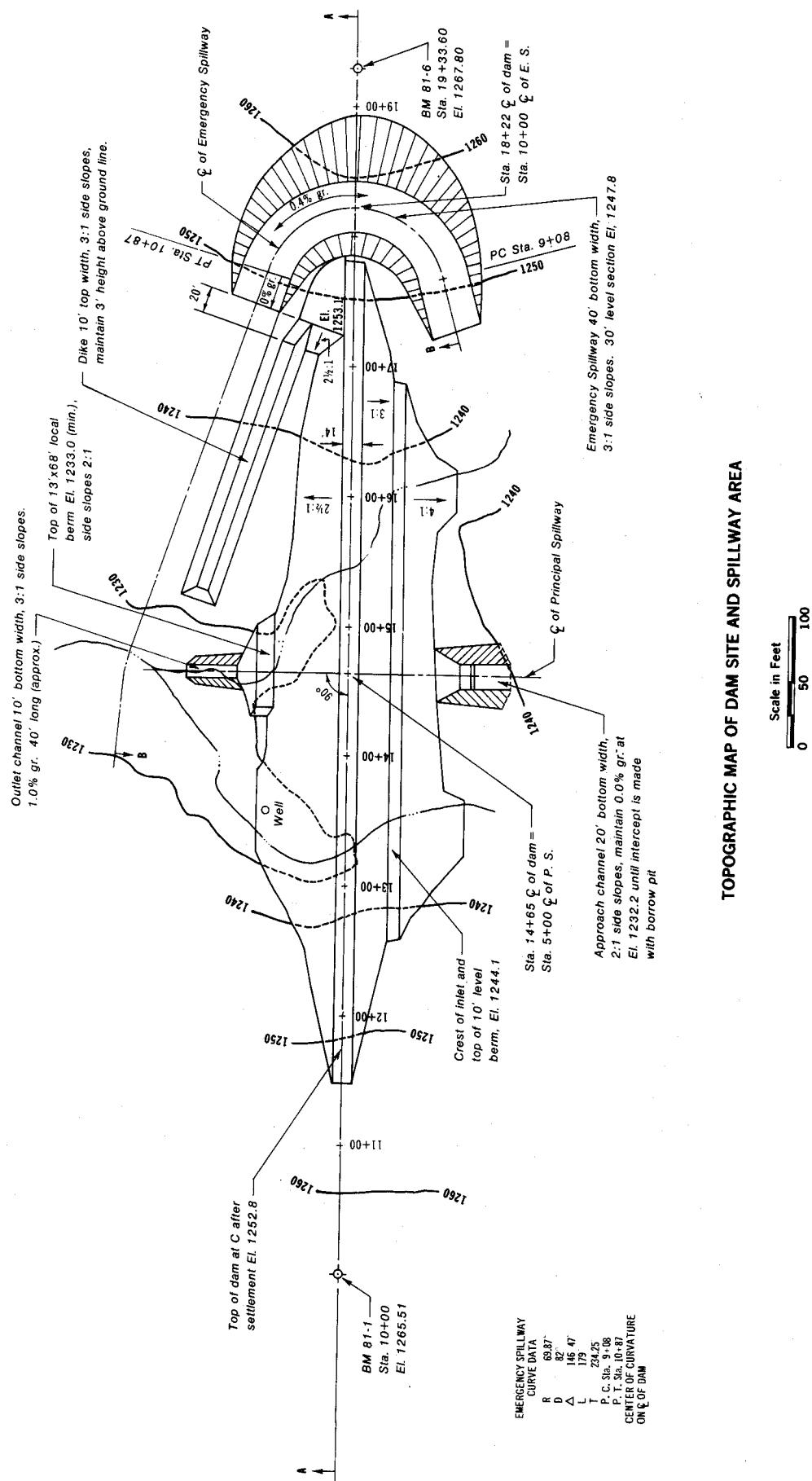


Figure 3-1

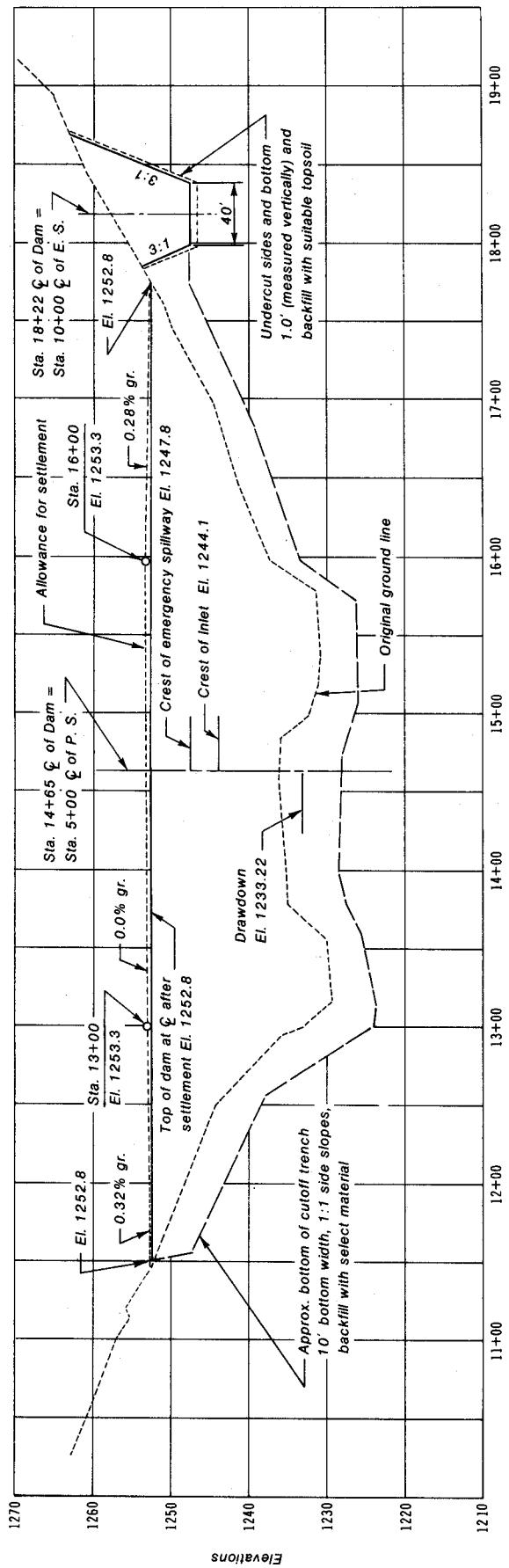
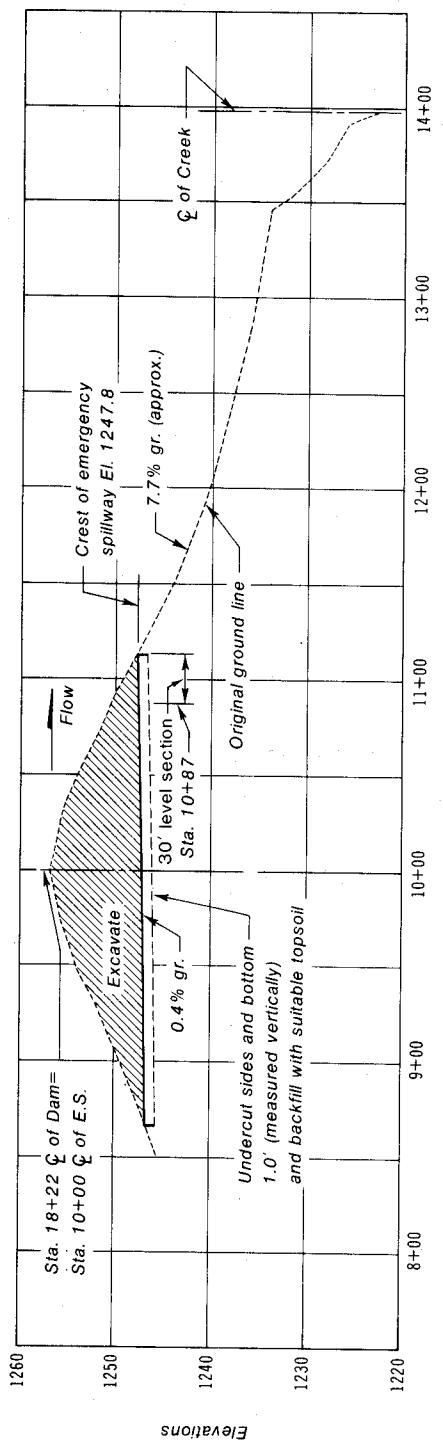
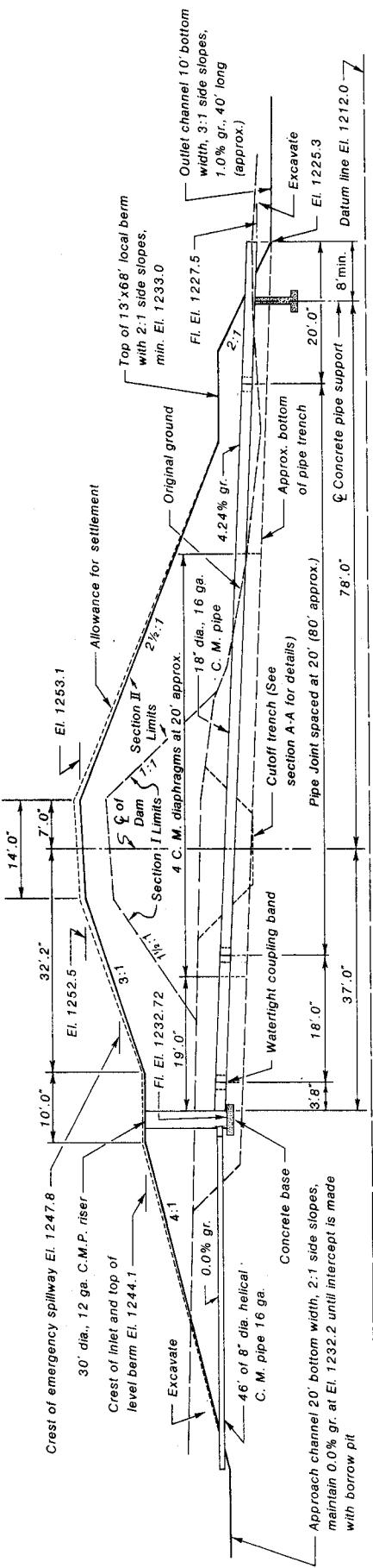


Figure 3-2



PROFILE ALONG £ OF EMERGENCY SPILLWAY

Figure 3-3



CROSS SECTION OF DAM ALONG Q OF PRINCIPAL SPILLWAY

(Sta. 14+65)

Figure 3-4

Figure 3-5 Sheet 1 of 2

BM Level Circuit						McVicker Beason	7/17/00
Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.			
BM 81-1	1.75	1267.26		1265.51		Top of $\frac{1}{2}$ " rebar set in concrete @ Sta. 10+00 ε of dam guarded by R&W steel post.	
TP	0.22	1255.33	12.15	1255.11			
TP	1.15	1243.70	12.78	1242.55			
TP	9.17	1240.51	12.36	1231.34		Top of south steel handle on well cap	
TP	11.61	1250.75	1.37	1239.14			
TP	12.60	1262.69	0.66	1250.09			
TP	8.51	1269.54	1.66	1261.03			
BM 81-6						Top of $\frac{1}{2}$ " rebar @ R&W steel post on ε of dam Sta. 19+33.60	
TP	0.35	1257.34	12.10	1256.99			
TP	1.54	1246.88	12.00	1245.34			
TP	9.77	1247.73	8.92	1237.96		Top of steel post	
TP	11.11	1250.26	0.58	1247.15			

Figure 3-5 Sheet 2 of 2

Figure 3-6 Sheet 1 of 2

EMBANKMENT		Stake Out Schedule		Elev. or Planned Elev.	Settlement	Constructed Elev.	Constructed Core Trench Elev
Sta.	B.S.	H.I.	F.S. or Grade Rod				
BERM	Settle- ment	Elev.	Const. Elev.				
11+51				1252.8	0.0	1252.8	
11+56					0.0	1252.8	1247.3
12+56					0.3	1253.1	1240.0 Begin berm
13+00	1244.1	0.3	1244.4		0.5	1253.3	1224.0
13+15		0.3	1244.4		0.5	1253.3	1224.0
13+60		0.3	1244.4		0.5	1253.3	1226.0 Ground core break
13+80		0.2	1244.3		0.5	1253.3	1227.5 Ground break
14+00		0.2	1244.3		0.5	1253.3	1227.0
14+75		0.2	1244.3		0.5	1253.3	1228.6
15+10		0.2	1244.3		0.5	1253.3	1226.5
15+75	1244.1	0.2	1244.3	1252.8	0.5	1253.3	1226.5

Figure 3-6 Sheet 2 of 2

Figure 3-7 Sheet 1 of 1

PRINCIPAL SPILLWAY Stake Out Schedule				L.T.	DIST. INCL. 50	R.T. DIST. INCL. 50 ₁₆
Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.	SLOPE 1:1 Trench Bottom	SLOPE 1:1 Pipe Invert Grades Backfill Grades
4+50						
4+56						
4+64						
4+86						
5+00						
5+06						
5+26						
5+46						
5+66						
5+86						

(Backfill) 1232.72 Riser Base

Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.	SLOPE 1:1 Trench Bottom	SLOPE 1:1 Pipe Invert Grades Backfill Grades
4+50						
4+56						
4+64						
4+86						
5+00						
5+06						
5+26						
5+46						
5+66						
5+86						

1232.72 M/e/f

1231.75
Dem & Sta. 1446.5 @ 90°

1230.90

1231.15

1230.05

1229.20

1229.45

1228.35

1228.60

1230.30

1227.0

1226.2

1225.3

1227.50

EMERGENCY SPILLWAY			L.T.	R.T.
Sls.	B.S. Defl.	H.I. Control	DIST. INCL. 20	DIST. INCL. 20
			SLOPE 3:1	SLOPE 3:1
8+61				
			Curve Data	
			RP. 17+52.1	
			R = 69.87'	
			D = 82°	
			A = 146°47'	
			L = 179'	
			T = 234.25	
9+08 PC	0'00'	0'00'	PC Sta. 9+08	
			PT Sta. 10+87	
9+12	1°38'	3°17'	1246.1	
			1246.2	
9+37	11°53'	23°47'	1247.2	Sta. 10+00 ES = 18+22 E of Dam
			,	
9+62	22°08'	44°17'	1247.3	1246.3
			,	
9+87	32°23'	64°47'	1247.4	1246.4
10+00		75°26'		Dam E
10+12	42°38'	85°17'	1247.5	1246.5
			,	
	1	2		
	1	2		
	1	2		

Figure 3-8 Sheet 1 of 2

Figure 3-8 Sheet 2 of 2

EMERGENCY SPILLWAY		LT.		RT.	
Sta.	Stake Out Schedule		DIST. INCL.	DIST. INCL.	20
B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.	SLOPE 3:1 WING DIKE 10° TBP 3:1.55P	
Defl.	Central	Design	Subgrade	Elev.	
10+37	52°53' 105°47'		1247.6	1246.6	1253.1
10+62	63°08' 126°17'		1247.7	1246.7	1253.1
10+87 PT	73°23' 146°47'		1247.8	1246.8	1253.1
11+17			1247.8	1246.8	1253.1
11+37			1245.3	Natural Ground	1248.3
12+37					natural ground
13+37					
13+47					0+00 ft // ↓ 11-3-8 2-2

EMBANKMENT			DOWN(LT)	UP(RT)
Stake Out Notes			Gr. Rd. Fill Adj. -0.3 Dist. Adj. for Berm Slope 2 1/2 : 1 Settlement 0.2	Gr. Rd. Fill Adj. +0.3 Slope 3:1 & 4:1 Berm Settlement 0.2
Sta.	B.S. H.I. (1241.06) (1241.1)	F.S. or Grade Rod Elev. or Planned Elev.	Top Width = 14.0 SETTLEMENT 0.5	
15+10	-11.7	1252.8 F.i.l.l	F-23.6 F-25.2 F-23.9 F-22.2 F-17.4 F-15.6	
	-12.2	1253.3 Const.	11.4 13.0 11.7 10.0 5.2 3.4	
			48.0 38.0 32.0 0.0 19.0 33.0	
			(6) 17.7 (6) F-20.2 (7) F-14.6 (7) F-14.2 (6) F-5.2	
			5.5 8.0 2.4 2.0 2.0	
	-3.0	1244.1 Berm		
	-3.2	1244.3 Const.	-6.70 F-187-57.0 F-141-63.8 -73.8 34.6	
			2.43:1 31.6	
			F-18.2 13.7	
			6.0 1.5	
			87.0 93.8	

Note: Fills below the line used for computing slope distances. Use stamps where appropriate.

Checked:
 R. H. M.
 7/14/70

Figure 3-9 Sheet 1 of 2

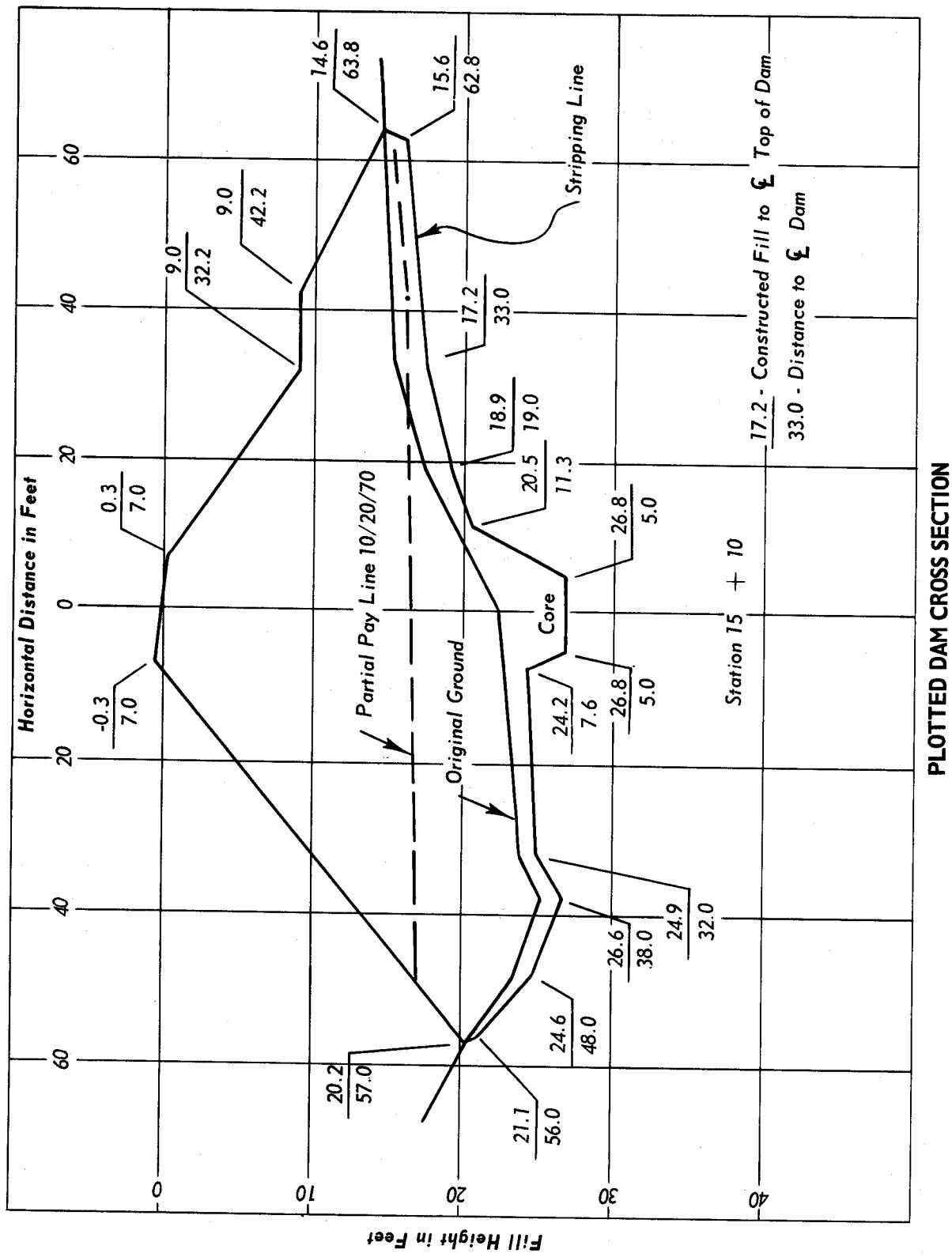
Figure 3-9 Sheet 2 of 2

Figure 3-10 Sheet 2 of 2

Figure 3-11 Sheet 1 of 1

Figure 3-12 Sheet 1 of 1

3-20



PLOTTED DAM CROSS SECTION

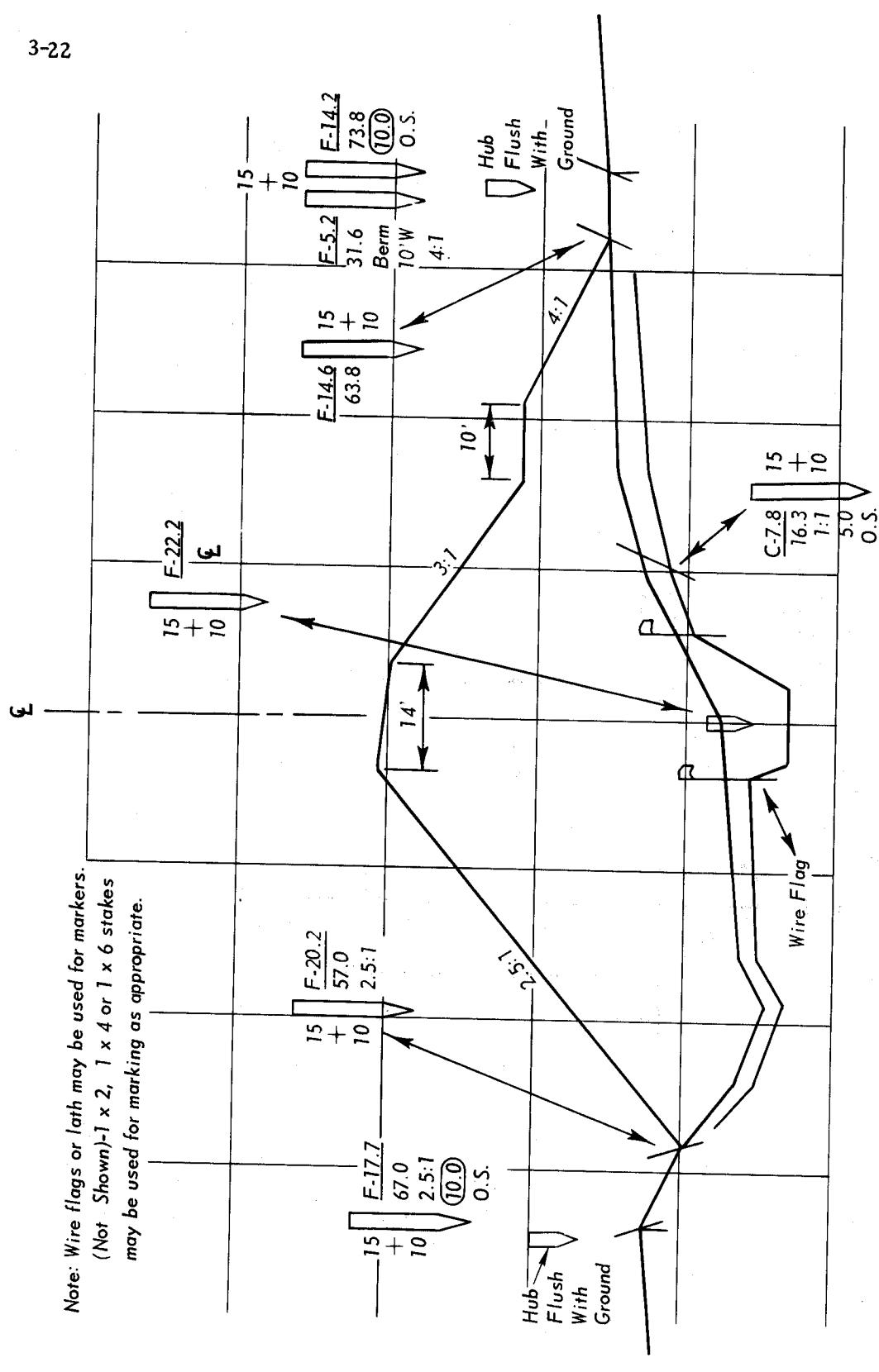
EARTHWORK COMPUTATION SHEET

LOCATION Frankfort, Kansas OWNER Williams Const. Co. CONTRACT NO. NBV-1C-4764
 WATERSHED NORTH Black Vermillion ITEM EARTH FILL-EMBANKMENT COMPUTED BY G. Nell
 SUB-WATERSHED SITE NO 81 FINAL QUANTITY cu. yds. CHECKED BY Hector
Brown Bros Const. Co.
 DATE 10/13 BY 70
 DATE 11/25 BY 70

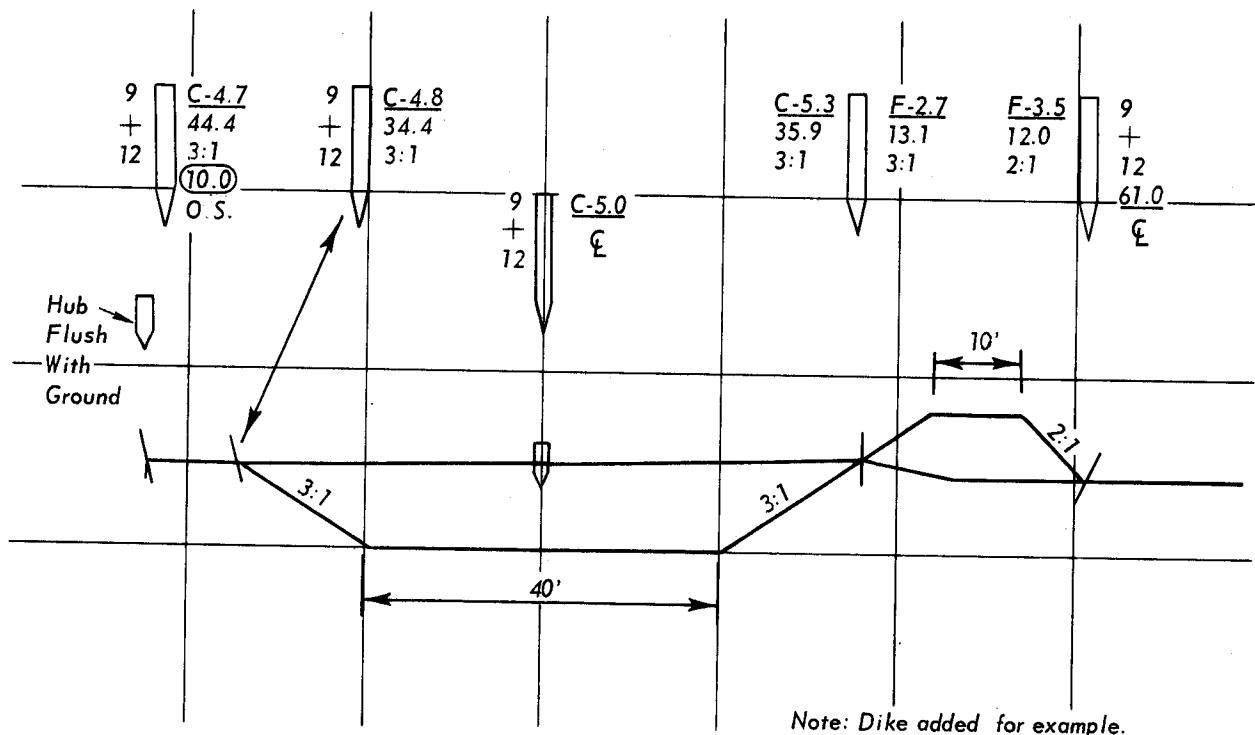
- * PROVIDE APPROPRIATE HEADINGS FOR USE OF OFFSET OR ζ BASELINE

Fig. 3-14 Sheet 1 of 1

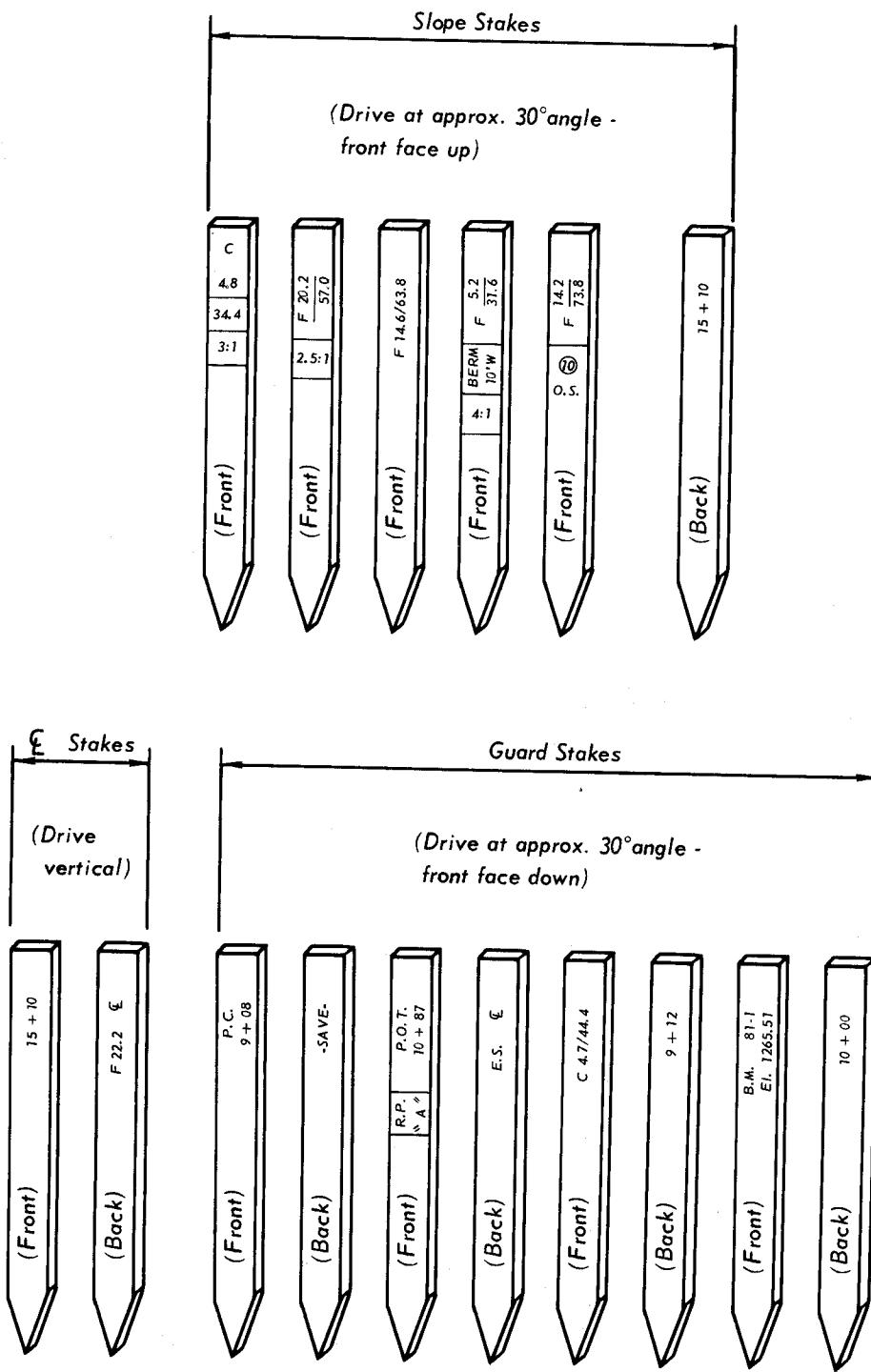
3-22



EXAMPLE FOR STAKING EMBANKMENTS

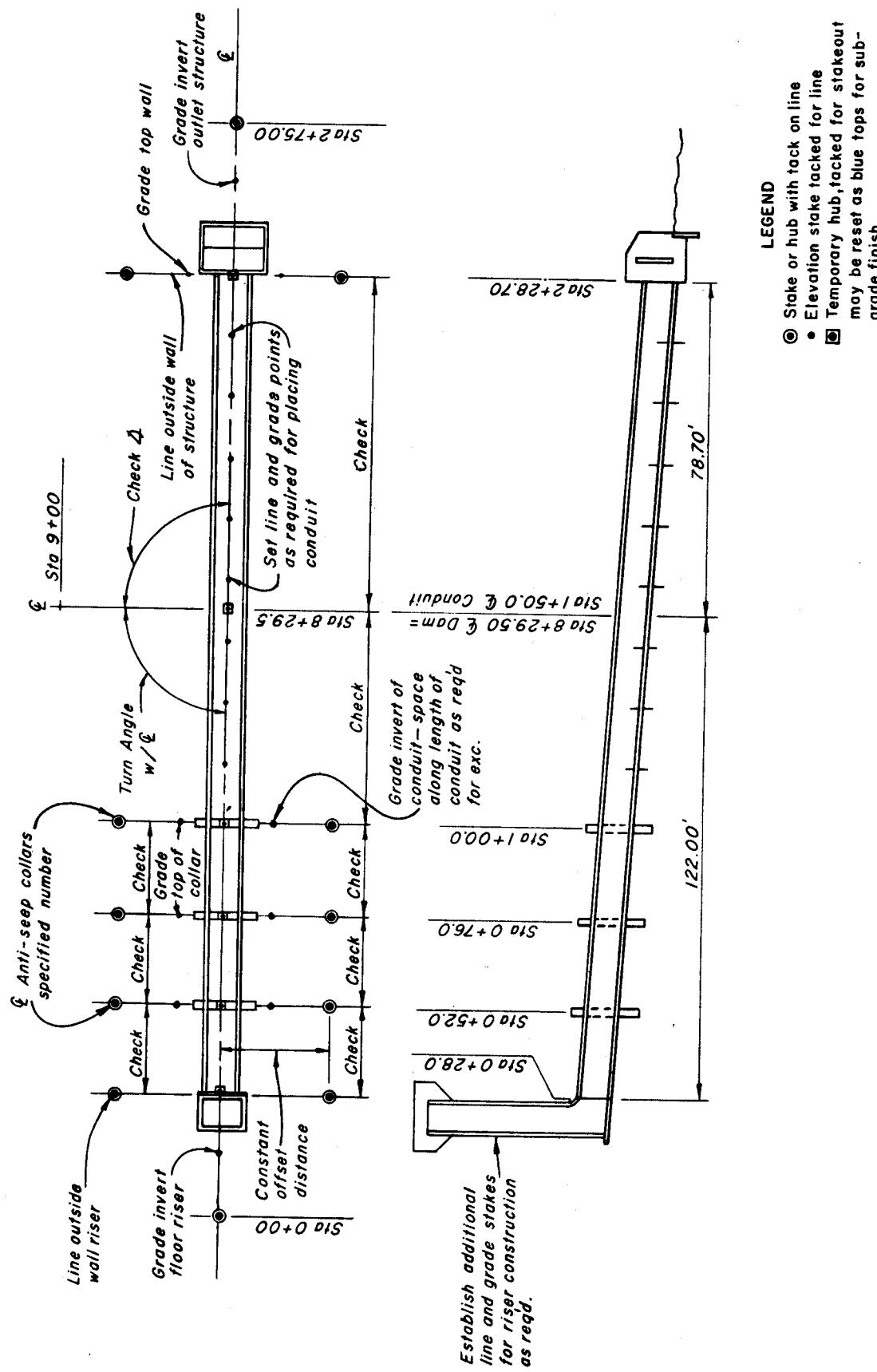


EXAMPLE FOR STAKING EXCAVATIONS
Figure 3-15 Sheet 1 of 1



EXAMPLES FOR MARKING CONSTRUCTION STAKES

Figure 3-16 Sheet 1 of 1



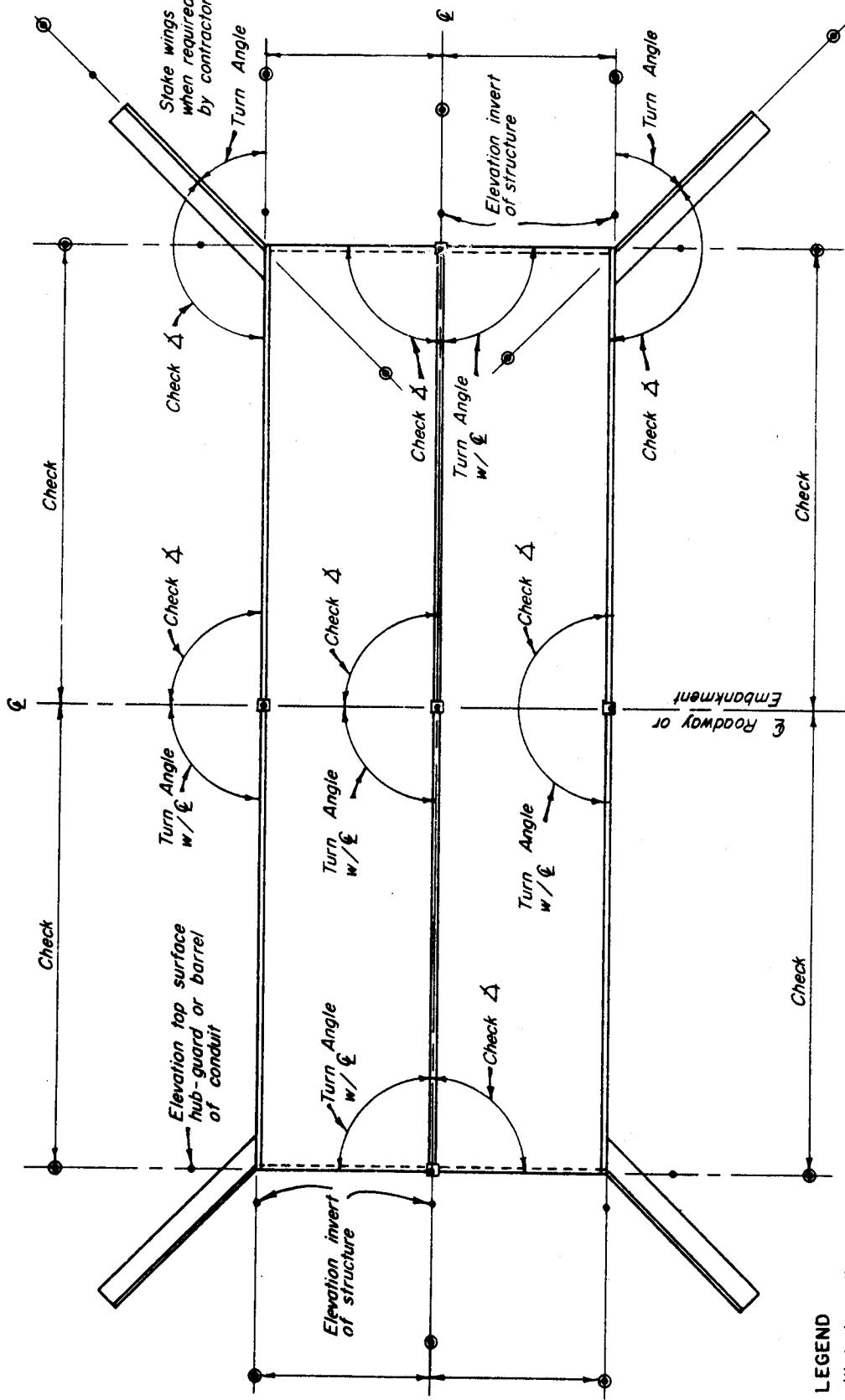


FIGURE 3-18 EXAMPLE FOR STAKING MULTIPLE BOX CONDUITS

LEGEND

- Stake with tack on line
- Elevation stake tacked for line
- Temporary hub tucked line

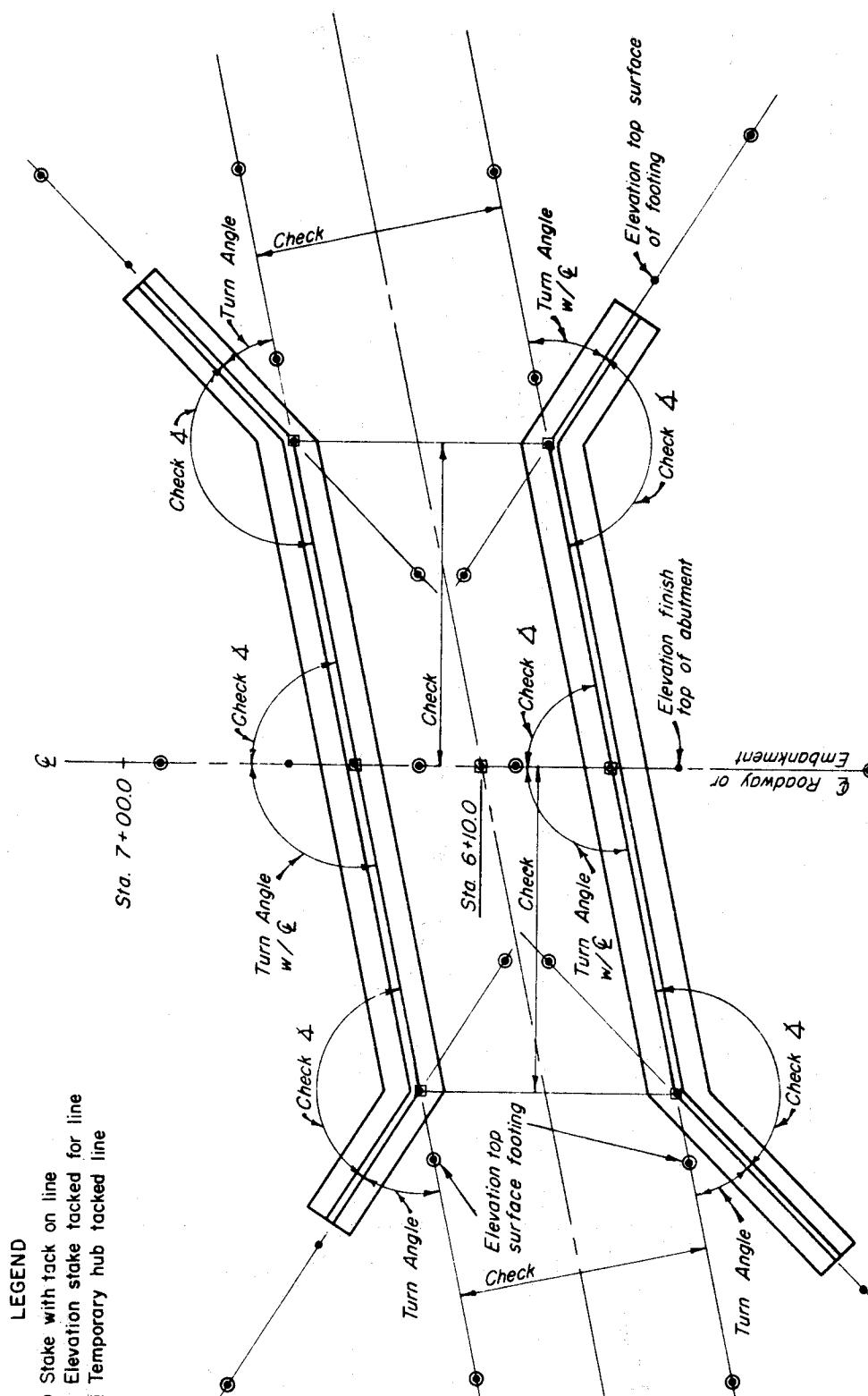


FIGURE 3-19 EXAMPLE FOR STAKING CANTILEVER ABUTMENTS ON SKEW ANGLE

Figure 3-20 Sheet 1 of 2

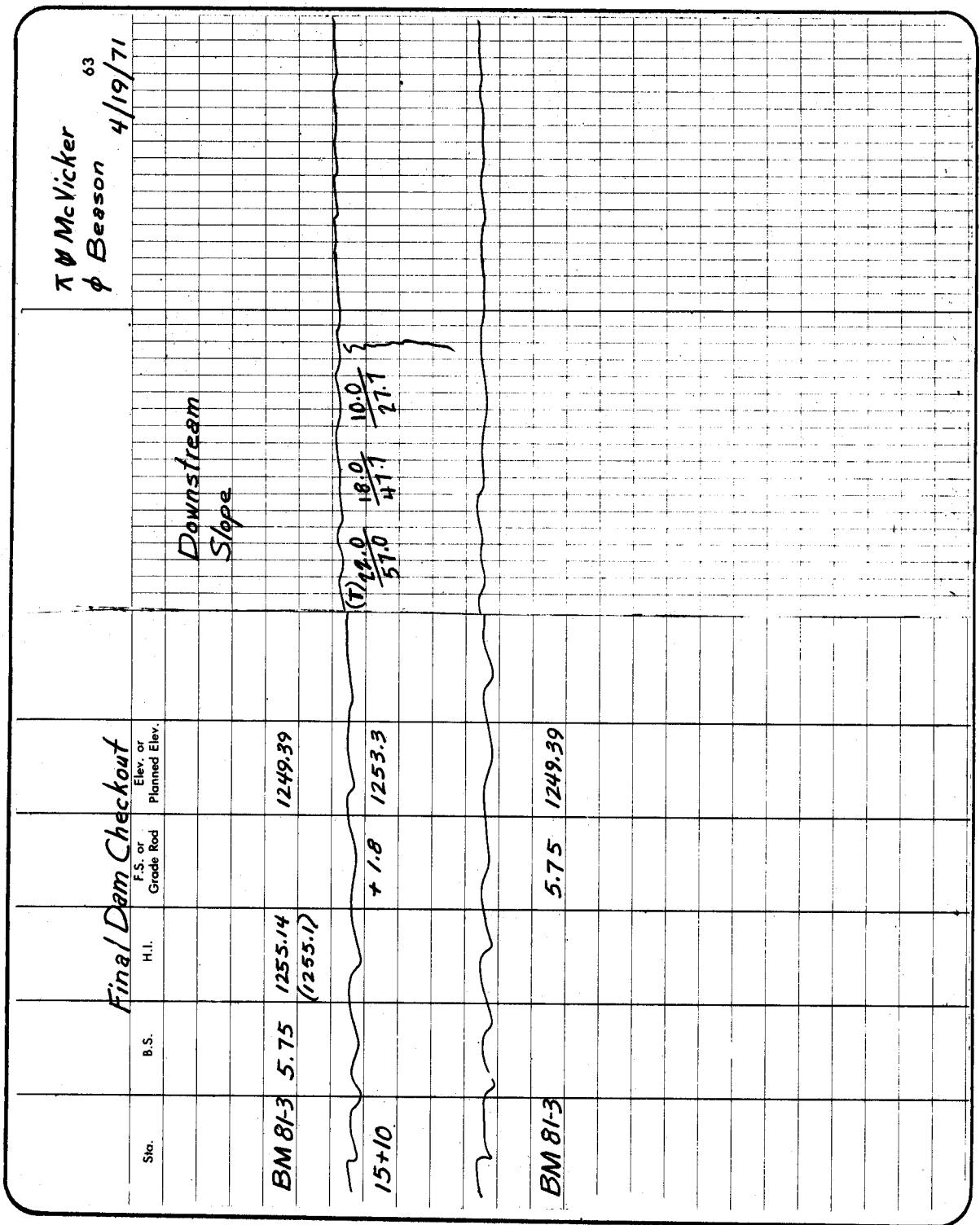


Figure 3-20 Sheet 2 of 2